EARLY COMPUTER SCIENCE LEARNING WITHOUT A COMPUTER

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Abstract

This work presents the activities of a teacher that creates and leads an educational process, which is co-created by students, according to their abilities. The aim of such learning process is early computer science and computational thinking education. The theoretical part explains problem-oriented teaching, computational thinking and why it should be developed already in the lower grades of primary school. Then the teaching activities are presented that enable students to learn computer science without devices. Problem oriented activities are based on a created stimulating learning environment with emphasis on critical thinking and creativity development. The activities were prepared in such a way that students of this age are familiar with the elements used.
Key words: *computational thinking education, early computer science education, problem-oriented education*

Introduction

Nowadays, teachers have a lot of freedom in planning and implementing the learning process. This enables us to carry out the learning process in different ways. What is the biggest challenge for a teacher? Heacox (2015) explains that for a lot of individuals it is the need to adapt to more various needs of students, learning methods and various social backgrounds of students.

It can happen that the way to the goal is more important than the goal itself. Some ways prove better than others. In modern times, we know that next to reading, writing and calculating, students need knowledge about how to use a computer, since life gives us new challenges every day. Thus, it's important to develop such a way of learning that provides the opportunities to develop strategies which will aid an individual to act alone in these changing social circumstances. "Such a person has to obtain knowledge that is needed for further education and function in the society." (Krek, 2022, p. 114).

"The focus of education has to be on the learners, on their experience, on their independent, conscious searching for new discoveries so they can activate their exploring processes, methodological and methodical experiences."

A problem-oriented learning innovation, thus problem solving, is a suitable approach for such purposes. Why? Because during such learning and teaching process, students actively face problems in form of learning content, enrich their experience, search independently for solutions, and get acquainted with solving methods and processes." (Strmčnik, 1992, p. 5).

"Only by independent solving of problems, basic characteristics of creative thinking and handling, for instance, divergency and critical thinking, can be developed and the same applies to innovation, the desire for new know-how, knowledge transfer and abilities to adapt to new situations, combining previous and new experiences, development of alternative solutions and processes etc." (Strmčnik, 1992, p. 6).

https://doi.org/10.48127/gu-nse/22.19.42

What is Learning with Technology and How Does It Work?

"Learning with technology are learning situations, in which we create the learning experience with the help of physical devices, such as computers and the Internet. Every learning process involves to some extent technology." (Dumont et al., 2013, p. 167).

"By learning with technology, we have a model of information processing. The information processing system consists of three ways of memorizing:

- Perceptual memory: can keep all incoming visual information in visual form and all incoming sounds in auditive form for a short time.
- Working memory: can keep a limited number of chosen words and pictures for further processing.
- Long-term memory: unlimited data storage.

Visual material and printed words step into the cognitive system of students through their eyes and stay for a short amount of time in the visual perceptual memory, while spoken words enter through the ears and stay for a limited time in the auditive perceptual memory. If the students are focused on the entering visual material, some of it can be transformed into working memory for further processing. If the students are focused on the entering auditive material, some of it can be transformed into working memory for further processing." (Dumont et al., 2013, p. 169).

Computational Thinking

The authors Kranjc et al. (2017) state in Education that some think of computational thinking as one of the key skills of students in the 21st century. Although computational thinking is understood as cognitive science that is closely connected to computational coding, coding is by far not the only activity that demands the utilization of computational thinking processes.

Computational thinking should therefore mean a way of thinking that can be an important tool for creative as well as critical thinking, decision making and problem solving. It assumes development of open problem solutions in a way that follows a series of well-defined steps. Students who cannot develop abilities of computational thinking are limited in their problem- solving skills. Furthermore, research shows that problem-solving skills are one of the most important predictors for learning and later working success.

The method of problems facing as it is presumed by computational thinking, is the key approach in problem solving for all professional areas. Computer science is no longer only a new and important view of world understanding but also an important aspect of all areas.

Kranjc et al. (2017) state that an individual cannot develop computational thinking to the full extent if such a person does not understand the basic principles of computer science and information technology. Thus, it is important for a student to systematically obtain the necessary knowledge on computational thinking in a guided and clear focused learning and teaching process.

The Project Day

While considering if first graders are able of computational thinking development, I was reading various literature and noticed that it isn't mandatory for students to have an actual computer in front of them.

As a class teacher, I asked an extended day care teacher for assistance. We organized a project day for the first graders. We prepared a stimulating learning environment for critical thinking development, creativity stimulation, and problem-oriented activities. Those were designed in such a way that students at that age were familiar with them (alphabet letters, counting to nine, moving by instructions). All presented activities are described in a master degree thesis (Ropret, 2019). We included cross-curricular content from mathematics, physical education, and art into the subject specific learning plans for Slovene language.

We kicked off the day with an activity where each student created their own robot from various materials. Such a robot came into action during other activities that followed.

The next activity, we called Alphabet. On the floor, we already created a square mesh. Each field contained one letter of the Slovenian alphabet. We discussed the starting field with the students. For moving along the net, we used the instructions step forward, step backward, step to the left, step to the right and squat. The command squat meant that the chosen student came to the designated letter by the person that spoke the commands.

After a few repetitions, we upgraded the activity by having the student who executed the commands "write out" the name of the one who dictated the commands. The next upgrade was in giving commands in a shorter form, as the students realized that if a command is repeated several times, they can say, for example, take four steps forward.

To make the activity more dynamic, we prepared another two meshes and divided students into groups that used the same commands, moved along the numbers, or simply had to reach their robot that we built in the beginning.

We didn't achieve the symbolic record, since our next step was the activity "If … else". Students gathered in a circle. The teacher read a statement. If the statement were to be true for a student, he or she had to carry it out, otherwise they didn't have to do anything. Students understood the statements beginning with "if", they had more troubles with the command "else", since they didn't understand the meaning of all statements.

In the final part of the day, students learned about following instructions and a sequence of commands. The teacher jumped into the role of Simon and in case of the phrase "Simon says" at the beginning of the command, students carried out the command, otherwise they didn't have to.

Conclusions and Implications

All carried out activities included in a didactical approach that leads a six-year-old through a game and brings him to understanding of basic computational thinking concepts with a significant range of own activity. Students developed listening comprehension and speaking skills, learned about the meaning of giving and understanding clear instructions, with their own engagement they obtained the knowledge, how important it is to give exact instructions and that there can be more than one method to reach the right solution.

It was observed that students started to connect and to merge expressions from basic to advanced level themselves. For instance, they united a sequence of same expressions into

 https://doi.org/10.48127/gu-nse/22.19.42

a group of commands and built some kind of subsequences. Students stepped within the DigComp 2.1 framework with recognizing of basic terms from logical and computational thinking (basic moving commands) to the level of foundation and discovered problems, tried to solve them, they were creative, got acquainted with coding without devices through games (gamification), developed solving strategies, learnt in a collaborative way and with teamwork. Within the groups, they took over the initiative and guided their fellow peers. They were active participants in preparing and designing the learning environment.

While offering new and different ways of obtaining knowledge, ways that didn't limit students in their work, the competences of teachers were expressed. Among them, the entrepreneurship competence "from idea to product" was visible, also vision, self-awareness, and self-efficiency, mastering of uncertainty, doubt, and risk. The above-described activity and method of learning proved as efficient, increased the students' motivation as well as their active involvement in school activities, since it stimulated them to own engagement and ideas, therefore I will give more focus to such methods and develop it further in the future.

Acknowledgement

The author gratefully wish to make acknowledgement to the Project No.: C3330-17-319016; Innovative learning environment supported by ICT – Innovative pedagogy 1:1 for financial support. The project is co-financed by the Republic of Slovenia and the European Union from the European Social Fund.

Note

This is a revised and expanded version of the 5th International Scientific Conference on *Philosophy of Mind and Cognitive Modelling in Education* paper in *Gamtamokslinis ugdymas / Natural Science Education*. The paper was recommended for republication by the conference scientific committee. Available: https://pce-fnm.si/conference-proceedings

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Received 08 September 2022; Accepted 28 September 2022

Cite as: Weis, K. (2022). Early computer science learning without a computer. *Gamtamokslinis ugdymas / Natural Science Education, 19*(1), 42-46. https://doi.org/10.48127/gu-nse/22.19.42

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